Long head of biceps brachii tendon, biceps-labral complex and the biceps pulley: Evaluation with MRI and MR arthrogram of the glenohumeral joint

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Authors: J. Singh, S. Tapasvi, A. Babhulkar; Pune/IN
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Learning objectives

1. To illustrate the anatomy of the intra-articular long head of biceps tendon, the biceps-labral complex and the biceps pulley.
2. To illustrate various pathologies affecting the long head of biceps brachii and the biceps labral complex.

Background

The intra-articular long head of biceps and the biceps-labral complex can be involved with various degenerative and sports related injuries. Understanding the anatomy of the long head of biceps and the biceps-labral complex is crucial to accurate interpretation of pathologies and their differentiation from normal anatomical variants.

The long head of biceps tendon (LHBT) can originate from the anterosuperior labrum, posterosuperior labrum, superaglenoid tubercle of glenoid and the base of the coracoid process. (1) LHBT traverses the rotator interval and is stabilized as it enters the bicipital groove predominantly by a pulley formed by the extension of the coracohumeral ligament and superior glenohumeral ligament. The LHBT is an intra-articular extrasynovial structure. (2) The exact function of the LHBT in the shoulder joint is controversial but it is believed to be a static restraint to glenohumeral motion, dynamic restraint to movement & stability as a proprioceptive organ. (3) Supraspinatus and subscapularis tendons reinforce the roof of the biceps pulley. The implication of this feature pertains to repair of the supraspinatus anterior tears. We must endeavour to repair the supraspinatus at the edge of the biceps groove to restore stability of the biceps tendon.

The labrum is a fibrocartilaginous structure that deepens the glenoid socket and serves as attachment of the capsule and glenohumeral ligaments. Superior labrum anterior and posterior (SLAP) tears can be a cause of pain as well as increased translation across the joint when they involve the LHBT. (4) The biceps-labral complex (BLC) attachment can be of three types: type I where the labrum is firmly attached to the glenoid, type II where there is a small sulcus beneath the labrum with a more medial attachment of the labrum and type III where the labrum is meniscoid with a large sulcus intervening between the bony glenoid and the labrum. (5) When interpreting SLAP tears, it is important to be aware of the biceps labral sulcus and sublabral foramen as normal variants. (1)
Normal anatomy of the LHBT

The long head of biceps tendon (LHBT) can originate from the anterosuperior labrum, posterosuperior labrum, superaglenoid tubercle of glenoid and the base of the coracoid process. (1) LHBT traverses the rotator interval and is stabilized as it enters the bicipital groove predominantly by a pulley formed by the extension of the coracohumeral ligament (CHL) and superior glenohumeral ligament (SGHL). The CHL originates from the lateral aspect of the base of the coracoid process and has two bands distally, the lateral band attaching to the greater tuberosity and anterior border of supraspinatus tendon and a medial band attaching to the lesser tuberosity, superior fibers of subscapularis and transverse ligament. The SGHL runs from the superaglenoid tubercle to get attached on the lesser tuberosity blending with the CHL distally. (6) The CHL and SGHL form a U shaped sling around the LHBT as it enters the bicipital groove to form a pulley at its critical exit angle. (2,6)
Fig. 1: Normal anatomy of long head of biceps tendon (LHBT), superior glenohumeral ligament (SGHL) and coracohumeral ligament (CHL) as seen on MR arthrogram axial (a,b) and coronal oblique (c-e) images. LHBT (yellow arrow) traverses from superior glenoid pole (e) through the rotator interval (d) into the bicipital groove (c). SGHL (green arrow) and CHL (red arrow) form the pulley that stabilizes the LHBT as it enters the bicipital groove. Also seen is a paralabral cyst (pink arrow) in this patient with an anterior labral tear.

Fig. 2: Normal anatomy of biceps pulley as seen on MR arthrogram sagittal oblique images (a-e: lateral to medial). The pulley is a U shaped sling around the LHBT (yellow arrow) formed by the coracohumeral ligament (red arrow) and SGHL (green arrow) distally where they fuse in a T shaped manner (a). SCP=subscapularis, SSP=supraspinatus, ISP=infraspinatus and TM=teres minor muscle and tendons.
Fig. 3: Normal anatomy of biceps pulley system. Sagittal oblique image (a) in another patient. LHBT = long head of the biceps tendon, SGHL = supraglenoid bicipital ligament (red arrow). Axial MR arthrogram image (b) showing synovial bands (red arrow) called vincula biceps that attach the LHBT in the proximal bicipital groove.
Fig. 4: Bifid biceps (yellow arrow), a normal variation as seen on sagittal oblique (a), coronal oblique (b,c) and axial (d-f) MR arthrogram images.

Tendinosis of LHBT

Can be primary, when it is the isolated pathology or secondary e.g.: when associated with impingement.

Imaging reveals increased signal intensity with thickening of the tendon.
LHB tendinosis. Fat saturated T2 weighted coronal oblique (a) and sagittal oblique (b-d) images showing an anterior cuff tear (green arrow) with abnormal hyperintensity and thickening of the LHB (yellow arrow) suggestive of tendinosis. The patient underwent arthroscopic cuff repair and LHB tenotomy.
Fig. 5b: LHB tendinosis. Fat saturated proton density axial (a), T2W axial (b), proton density coronal oblique (c,d) and fat saturated proton density sagittal oblique (e) images in a patient with severe osteoarthritis and multiple loose bodies in the glenohumeral joint. The LHBT at origin and in rotator interval is markedly enlarged and hyperintense suggestive of tendinosis. The patient underwent arthroscopic removal of loose bodies and LHB tenotomy.

Tenosynovitis of LHBT
Inflammation of the tendon sheath.

Imaging reveals isolated or disproportionately large (more than glenohumeral joint effusion) amount of fluid in the tendon sheath of LHBT.
Fig. 6: LHB Tenosynovitis. Fat saturated proton density coronal oblique (a-d) and axial (e) images and T2 weighted coronal oblique images (f) in a patient with severe cuff tendinosis and LHB Tendinosis in its course in rotator interval (yellow arrow in c) with osteoarthritis. The focal fluid around the LHB Tendinosis in its course in the bicipital groove (yellow arrow in a) that does not communicate with the joint effusion is suggestive of tenosynovitis. The patient underwent physiotherapy and is being treated conservatively.

Rupture of LHB Tendinosis

Is usually due to repetitive wear and tear e.g. as occurs in impingement and rarely can be due to violent trauma.

Common site of tear is at the rotator interval.

Imaging reveals absence of the LHB Tendinosis in its intra-articular course and in the bicipital groove as the ruptured tendon gets retracted in the arm. A proximal stump of LHB Tendinosis at origin may be seen.
Fig. 7: LHB rupture. Fat saturated proton density axial (a) and MR arthrogram axial (b), coronal oblique (c) and sagittal oblique (d-f) images showing the absence of the LHBT in the bicipital groove (yellow arrow in a,b). A stump of the LHBT (yellow arrow in d) is seen in this patient with tear of the tendon in its course in the rotator interval and non-visualisation of the tendon on immediate sagittal oblique image (e) beneath the retracted torn cuff (e,f).

Biceps instability

Subluxation or dislocation

Dislocation when there is no contact between LHBT and bicipital groove.

Habermeyer classification of biceps pulley lesions

Type I

Isolated biceps pulley lesions, intact supraspinatus & subscapularis tendons.
<table>
<thead>
<tr>
<th>Type II</th>
<th>Biceps pulley lesion with partial articular surface supraspinatus tear. Mild medial subluxation of LHBT.</th>
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<tbody>
<tr>
<td>Type III</td>
<td>Biceps pulley lesion with partial tear of superior distal subscapularis tendon. Medial subluxation of LHBT.</td>
</tr>
<tr>
<td>Type IV</td>
<td>Biceps pulley lesion with partial tears of both supraspinatus &amp; subscapularis tendons. Frank medial subluxation of LHBT.</td>
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LHBT instability pattern is of following types:

**Intra-articular dislocation:** Both the pulley and subscapularis tendon are torn & LHBT dislocated into the glenohumeral joint.

**Subluxation anterior to subscapularis tendon but deep to lateral band of CHL:** tear of SGHL-medial CHL sling with intact lateral band.

**Extra-articular subluxation:** LHBT subluxated anterior to both subscapularis tendon & CHL. Due to anterolateral supraspinatus tear and tear of lateral band of CHL.

**Subluxation into subscapularis tendon:** tear of SGHL-medial CHL sling and delamination of deep surface of subscapularis tendon.
Fig. 8: Intra-articular dislocation of the LHBT. Fat saturated proton density axial (a) and fat saturated T2 weighted coronal oblique (b) and axial (c,d) images in a patient with subscapularis tendon and CHL (red arrow in c) tear with intra-articular dislocation of the LHBT (yellow arrow).
Fig. 9: Intra-articular dislocation of the LHBT. Fat saturated proton density axial (a), fat saturated T2 weighted axial (b) and MR arthrogram coronal oblique (c) and axial (d-f) in a patient who presented with anterior instability due to a subscapularis tendon tear (pink arrow in c,e,f). There is dislocation of the LHBT (yellow arrow) medially and anterior to the glenohumeral joint.
Fig. 10: Extra-articular subluxation of the LHBT. MR arthrogram sagittal oblique (b) and axial (c,d) images in a patient with isolated pulley lesion and subluxation of the LHBT anterior to subscapularis tendon. Compare this to the normal anatomy of the pulley on axial MR arthrogram images (a) in another patient. LHBT (yellow arrow), SGHL (green arrow), coracohumeral ligament (red arrow) & subscapularis tendon (pink arrow).
Fig. 11: Extra-articular subluxation of the LHBT. Proton density coronal oblique (a) and fat saturated proton density axial (b,c) images in a patient with subluxation of the LHBT (yellow arrow) anterior to subscapularis tendon (pink arrow) but deep to an intact lateral band of CHL (red arrow).

Treatment of LHBT tendinosis and instability (2)

1. Non operative: rest, non-steroidal anti-inflammatory medication, intra-articular or subacromial steroid injections, and appropriate exercises. Limited role of non-operative treatment for instability.

2. Operative:
   a. Tendon debridement - for mild tendon fraying and for older, less active patients with partial tears
   b. Tendon decompression - tenosynovial release for isolated tenosynovitis
   c. Tenotomy - preferred for older, less active patients
   d. Tenodesis - fixation above or below the bicipital groove. Advantages include better restoration of strength and absence of development of Popeye deformity. Disadvantages include
of implants, more skilled surgery requiring immobilization and longer rehabilitation programme.

e. Reconstruction of the sling of SGHL and CHL

**Normal anatomy of the BLC**

The labrum is a fibrocartilaginous structure that deepens the glenoid socket and serves as attachment of the capsule and glenohumeral ligaments. The biceps-labral complex (BLC) attachment can be of three types: type I where the labrum is firmly attached to the glenoid, type II where there is a small sulcus beneath the labrum with a more medial attachment of the labrum and type III where the labrum is meniscoid with a large sulcus intervening between the bony glenoid and the labrum. (5)
Normal variation seen in 11% of individuals.

Anterosuperior labrum is not attached to bony glenoid creating the foramen.

Diagnostic pearl: Does not extend posterior to the biceps anchor.

**Fig. 13: Sublabral foramen.** MR arthrogram coronal oblique (a-c) and axial (d-g) images showing a sublabral foramen that is formed due to the anterosuperior labrum (pink arrow) being unattached to the bony glenoid. The sublabral foramen does not extend posterior to the biceps anchor (c) and inferior to the equator (g). These features allow differentiation from a SLAP lesion and an anterior labral tear respectively.

**Biceps labral sulcus (superior sublabral recess)**

Located at the BLC.

Important to differentiate it from type II SLAP tears.
Diagnostic pearl: Usually less than 3mm and smooth, a sulcus greater than 5mm suggests a SLAP tear. Irregularity and lateral extension suggest SLAP tear.

**SLAP tear**

Superior labral anterior and posterior tears

Type I: Fraying of the superior labrum.

Type II: Detachment of BLC.

Type III: Bucket handle tear of superior labrum with intact biceps tendon.

Type IV: Bucket handle tear of superior labrum with extension into biceps tendon.

Type V: Bankart (anteroinferior labral) tear extending superiorly to biceps attachment.

Type VI: Flap tear with involvement of biceps tendon.

Type VII: SLAP lesion extending into middle glenohumeral ligament.

Type VIII: SLAP lesion extending into posterior labrum.

Type IX: SLAP lesion extending into anterior and posterior labrum.

Type X: SLAP lesion extending into rotator interval through superior glenohumeral ligament.
Fig. 14: Type II SLAP tear. MR arthrogram coronal oblique (a,b) images showing detachment of the superior labrum and biceps anchor suggestive of a type II SLAP tear in a young basketball player. The findings were confirmed at arthroscopy and the patient underwent arthroscopic repair. Note the hyperintense signal of the SLAP tear is broad, extends posterior to the biceps anchor and points laterally (best seen in b) thus differentiating it from a biceps labral sulcus.
Fig. 15: Type IV SLAP tear. MR arthrogram coronal oblique (a-d) images showing a bucket handle tear of the superior labrum extending into the biceps anchor suggestive of a type IV SLAP tear in a professional badminton player. The findings were confirmed at arthroscopy and the patient underwent arthroscopic repair.
Fig. 16: SLAP tear with posterior labral tear and paralabral cyst in spinoglenoid notch causing infraspinatus denervation. Fat saturated T2 weighted coronal oblique (a,b), fat saturated proton density axial (c) and MR arthrogram coronal oblique (d-f) and axial (g) images in a patient with cuff weakness who had failed a rehabilitation programme. There is abnormal hyperintensity of the infraspinatus muscle (pink arrow in a,b) suggestive of edema due to denervation caused due to suprascapular nerve entrapment in the spinoglenoid notch by a paralabral cyst (orange arrow in b,c,e). The superior and posterior labral tear (red arrow in d-g) have resulted in the formation of the paralabral cyst.
Fig. 17: Type IX SLAP tear. MR arthrogram coronal oblique (a-d) and axial (e) images showing a SLAP tear extending into the anterior as well as posterior labrum suggestive of a Type IX SLAP tear.

Treatment of SLAP lesion (2)

1. Non-operative: rest, non-steroidal anti-inflammatory drugs and appropriate exercises for muscle strengthening
2. Operative: debridement for type I lesion, arthroscopic repair for type II lesion, removal of bucket handle tear for type III lesion, debridement of labral tear with repair of biceps anchor or tenodesis for type IV lesion. For types V, VI, VII SLAP tears, the associated anterior/posterior labral tears are also repaired while for type VIII, IX and X, the labrum is reattached and flaps debrided.
MRI and MR arthrogram depict the anatomy and pathology of the intra-articular long head of biceps tendon and biceps-labral complex well.

A thorough knowledge of the anatomy and of the normal variants is an essential prerequisite for evaluation of the pathologies.

Personal Information

Dr. Joshita Singh  
Consultant Radiologist  
Deenanath Mangeshkar Hospital and Research Center  
Erandawane  
Pune – 411004  
India  
joshitasingh@hotmail.com

Fig.

References


